

Radionuclide Identification Using Identify and WESPA

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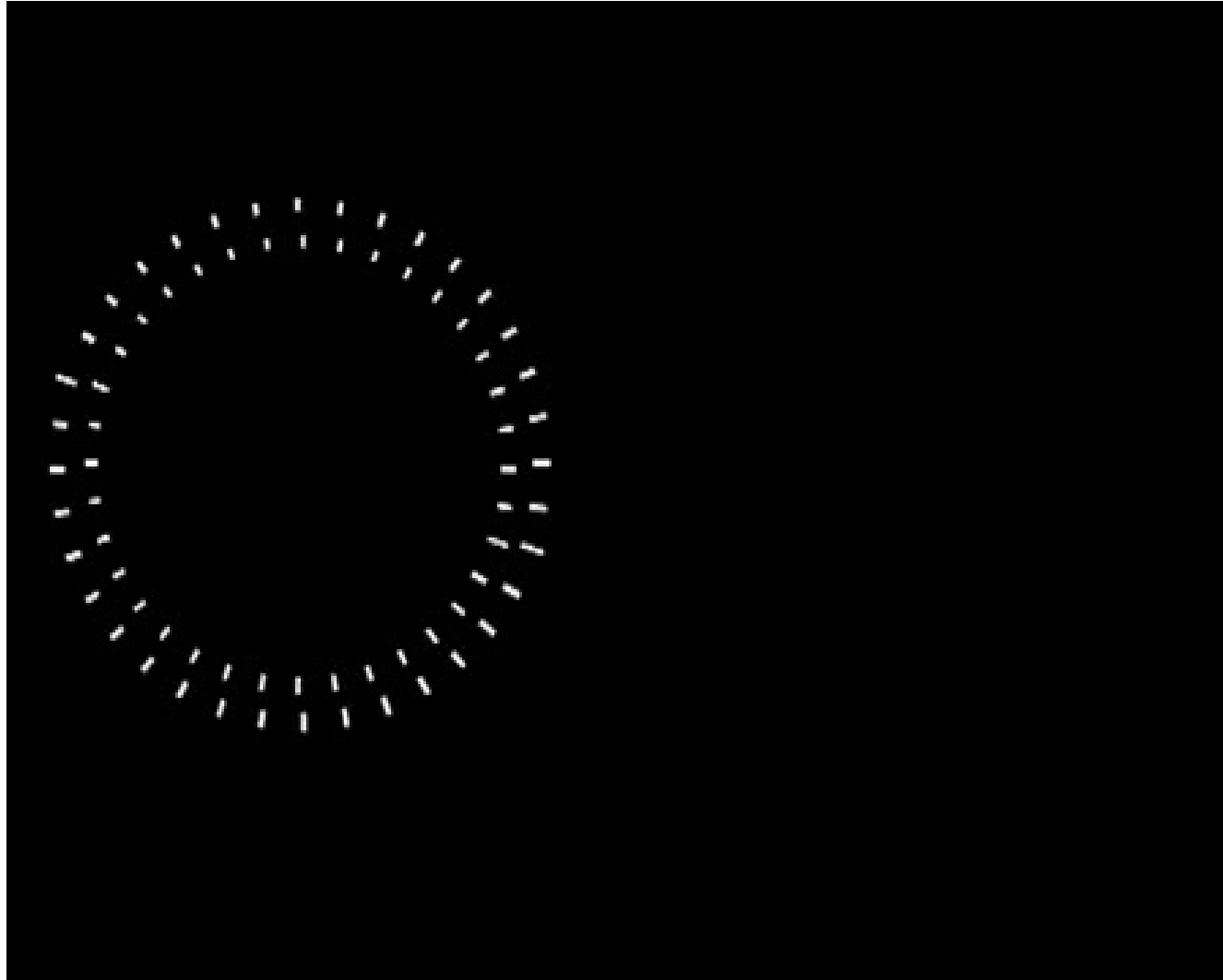
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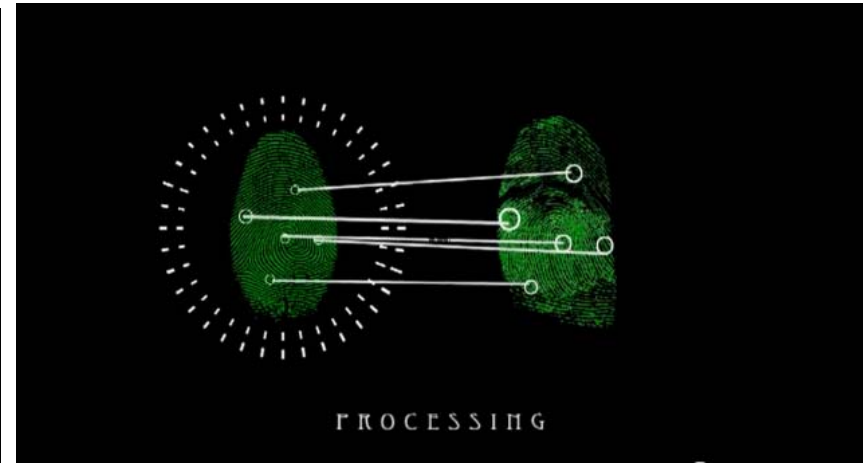
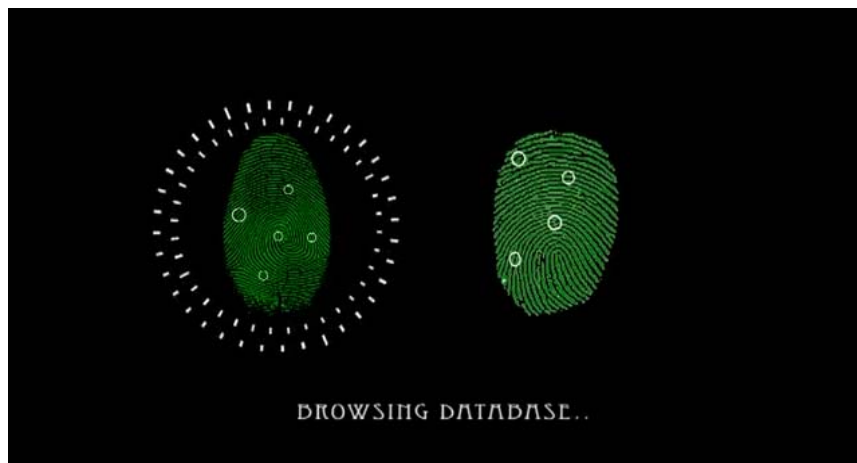
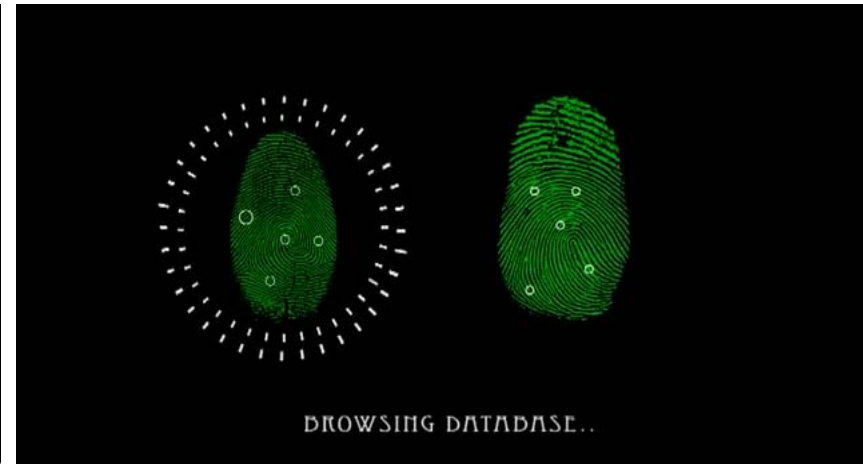
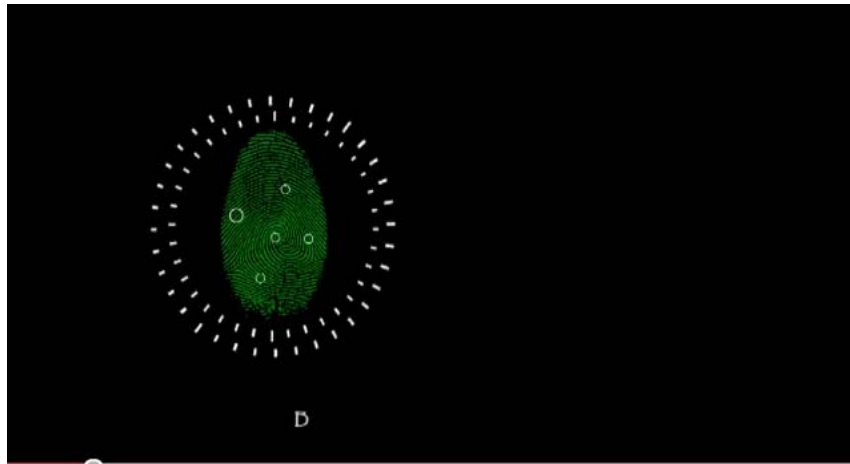
Agenda

- Fingerprint matching and isotope identification
- The Identify stand-alone isotope identification software
- The WESPA **W**eb-based **S**pectrum **A**nalyzer
- Applications

Fingerprint Matching



Fingerprint Matching



Similarities

- FP matching
 - Uniqueness
 - Database of fingerprints
 - Take fingerprint (FP)
 - Powder, foil, FP reader
 - Matching procedure
 - FP data base
 - Acceptance criteria
- Isotope ID
 - Uniqueness
 - Database of isotopes
 - Measure gamma spectrum with MCA
 - Matching procedure
 - Isotope libraries
 - Acceptance criteria

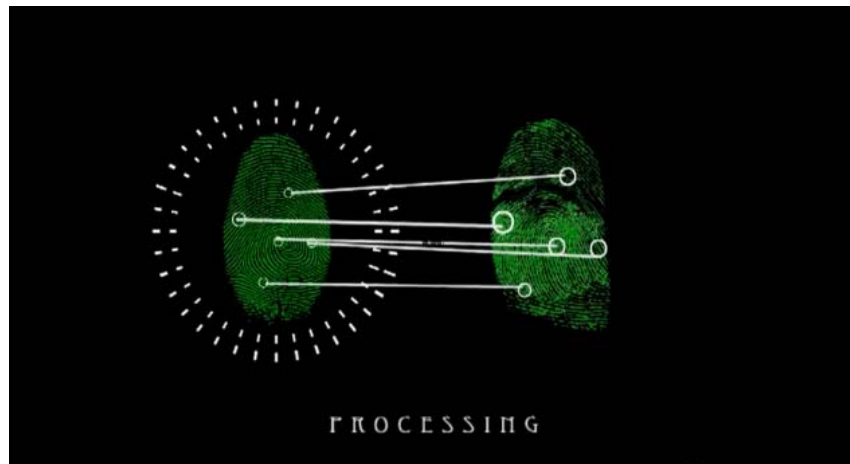
Reference Databases, e.g.

- Table of gamma energies and intensities (Identify, WESPA)
 - Matching of gamma lines (energy, intensity)

Ba133 3.326171E+08s
80.98keV/34.18%
223.23keV/0.4596%
276.38keV/7.085%
302.85keV/18.4%
355.99keV/62.15%
383.84keV/8.916%

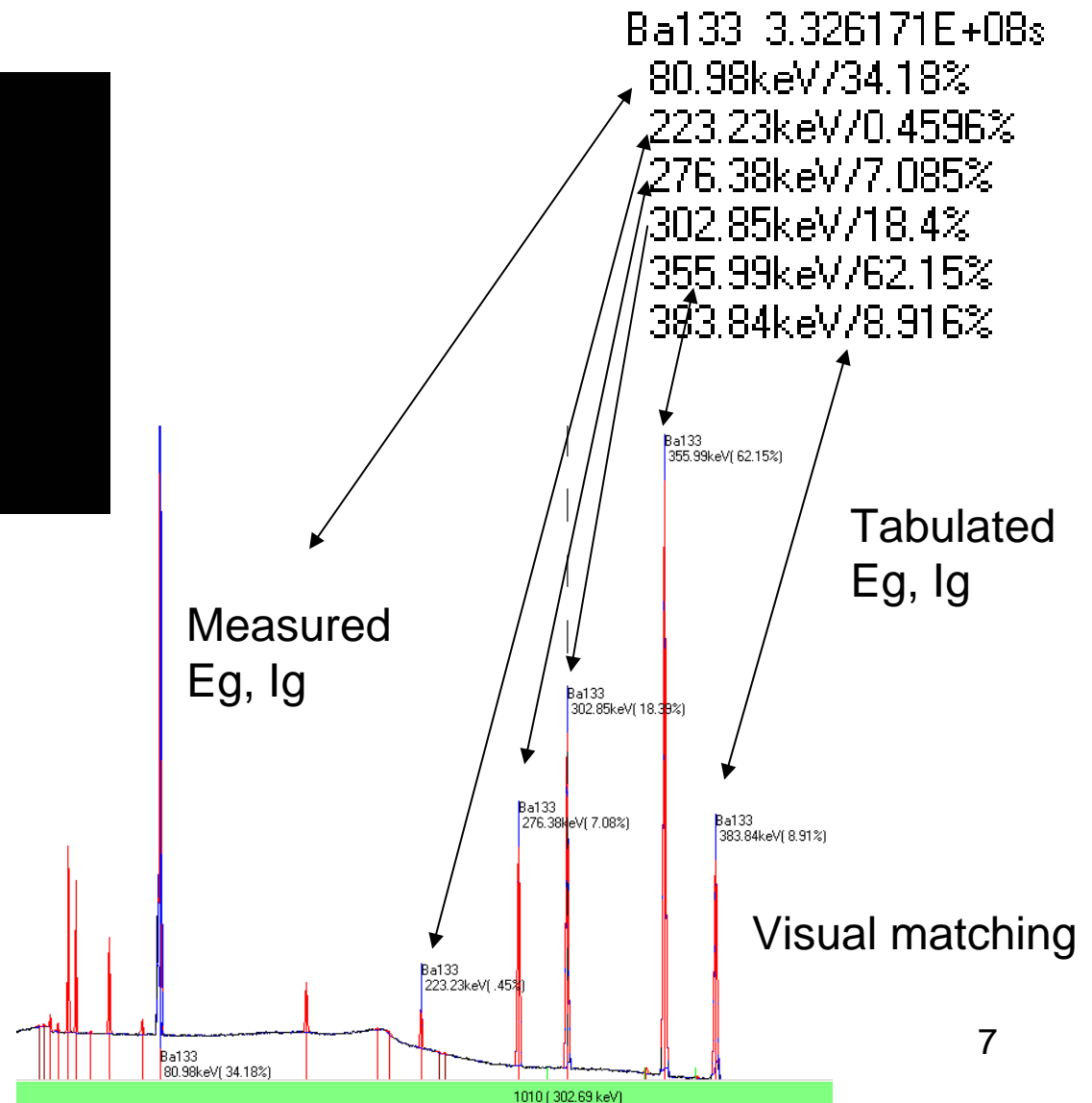
- Library of gamma spectra

Fingerprints and Spectrum Pattern



Finger print pattern
versus pattern
of measured gamma peaks

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Identify and WESPA

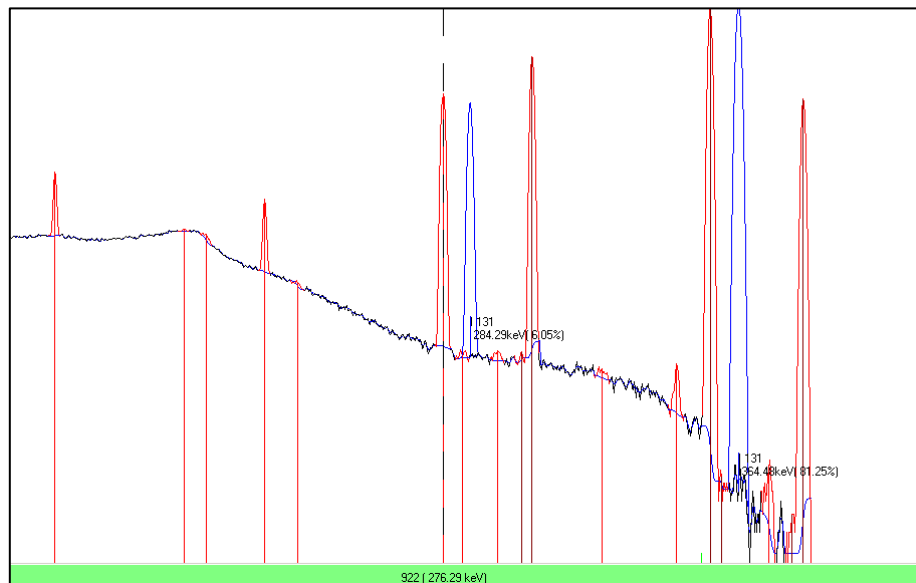
- Identify is a stand alone ID program
- Matching of tabulated Eg and Ig with measured values
- Matching is done manually and visually
- WESPA – adaptation of Identify to Nucleonica.net
- WESPA requires Internet connection

WESPA = Web- based Spectrum
Analyzer

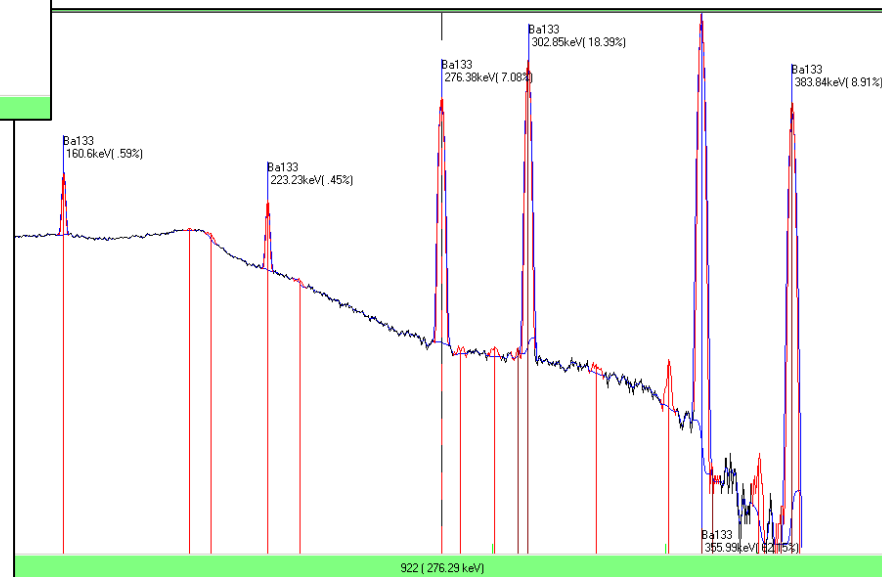
Key Features of Identify

- Expert interactive method
 - Setup
 - Peak Search
 - Associate a peak with one of the isotopes
 - Overlay peaks to measured spectrum
 - Compare both visually
 - Find isotope with best match (energy, intensity)

Match and Mismatch



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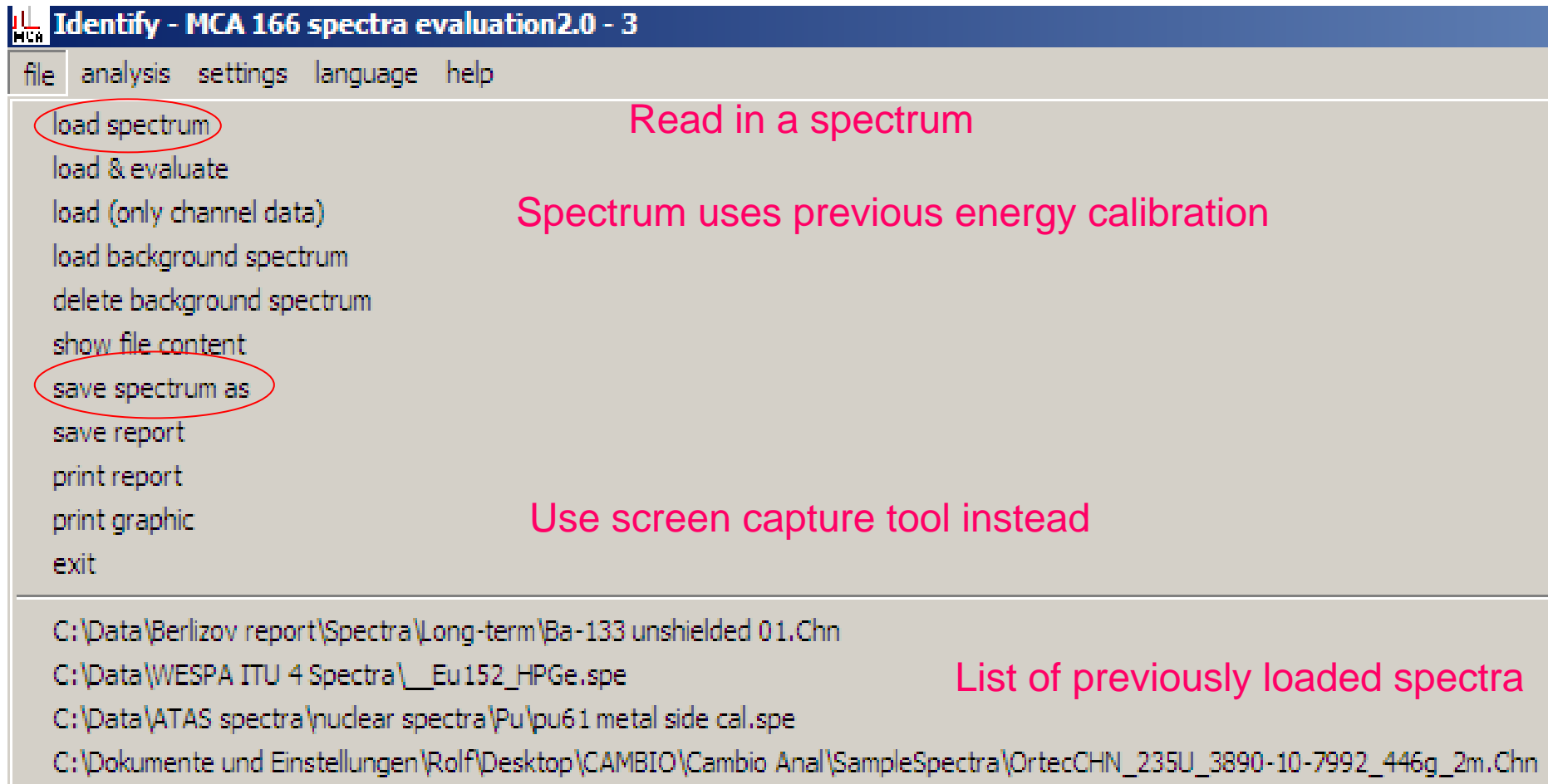
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Using Identify (demonstration)

- Read spectrum
- Energy calibration
- Setting up detector parameters, filters, absorbers, distances (use stored settings)
- Select a radioisotope library
- Peak search
- Mark a found gamma peak in the spectrum
- Display/overlay other gamma peaks of the candidate isotope
- Visually (aided by peak rating) find the isotope which matches best the measured gamma peak pattern

Identify File Menu



Identify Detector Function

detector function

detector geometry

detector:

detector area:

and

☐ thickness:

☒ relative efficiency compared to 3"3" NaI: %

☐ effective photopeak sensitive area at 662 keV: mm²

distance detector to radiation source: cm

proposed accuracy:

radiation window

aluminium: mm

germanium: mm

beryllium: mm

iron: mm

absorber

mm

matrix

mm

☒ absorber settings unsure

standard settings

peak form:

FWHM	FWexp	visual efficiency
<input type="text" value=".95"/>	<input type="text" value="0"/>	<input type="text" value="122"/>
<input type="text" value="1.83"/>	<input type="text" value="0"/>	<input type="text" value="1333"/>

keV at keV photon energy

cancel

OK

Identify Analysis Menu

analysis	settings	language	he
QuickID	Ctrl+Q		
<u>peak search</u>			
(auto FWHM search)			
Main library search	F12		
<u>Clear evaluation</u>	Ctrl+X		
fit this peak	F2		
Specinfo	F11		
Uran88_100			
modeling			

Automated processing of spectra, fixed settings

Finds peaks in a spectrum

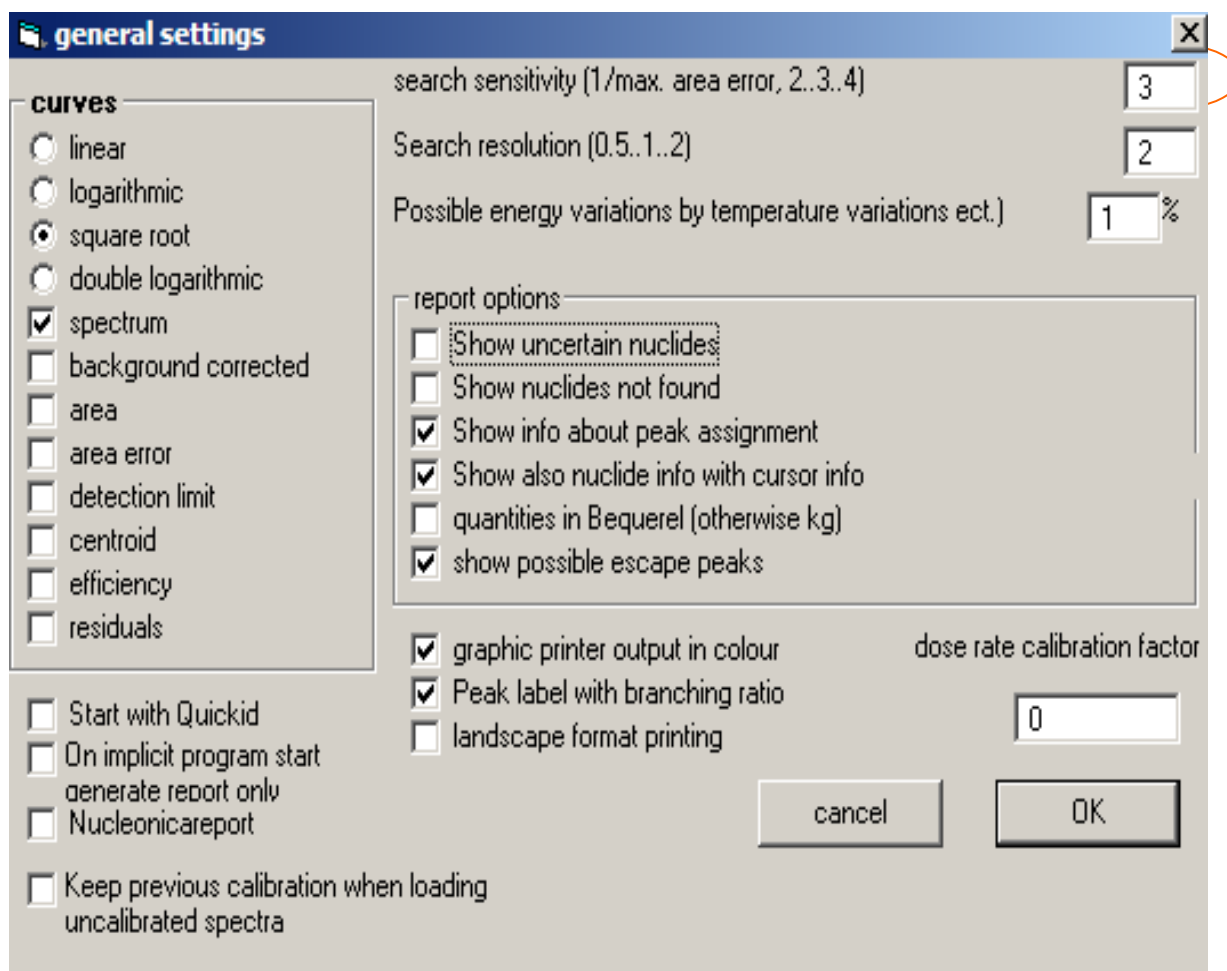
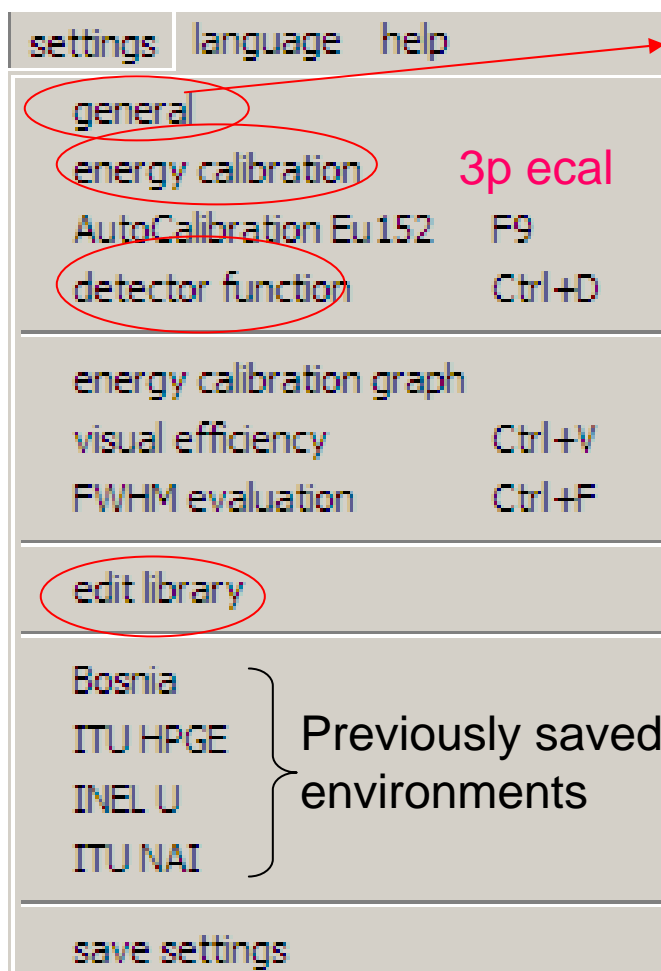
Peak search and simultaneous FWHM adjustment

Uses largest isotope library for search

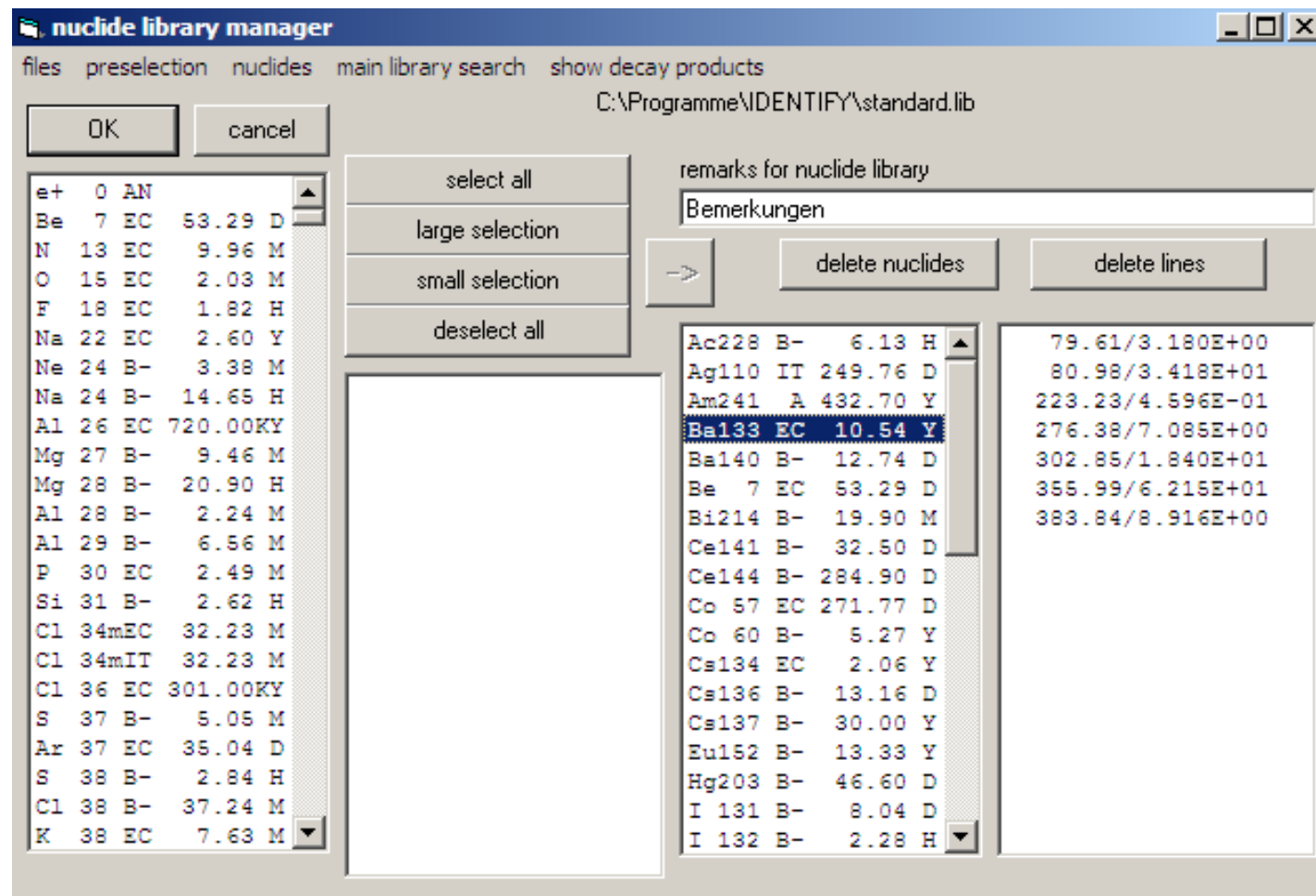
Clears evaluation allowing new one with diff. par.

Still under development & testing

Identify Settings Menu

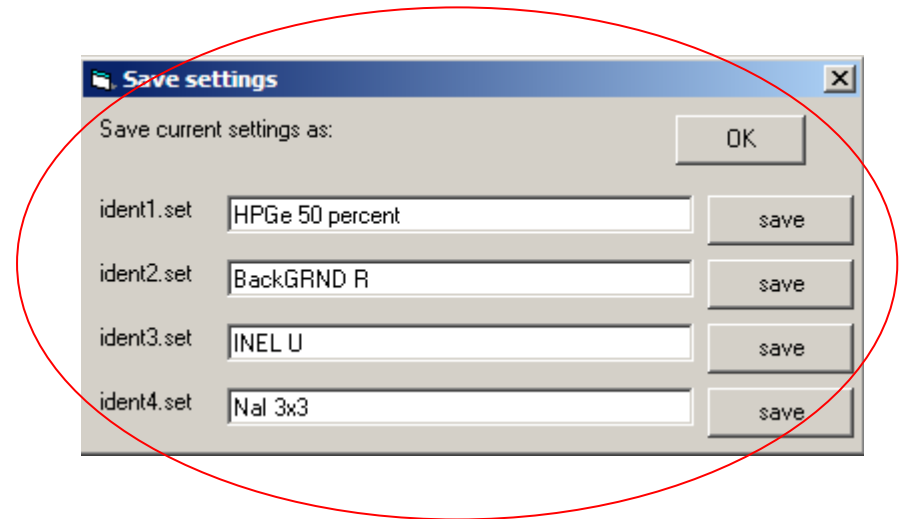


Gamma Library Editor

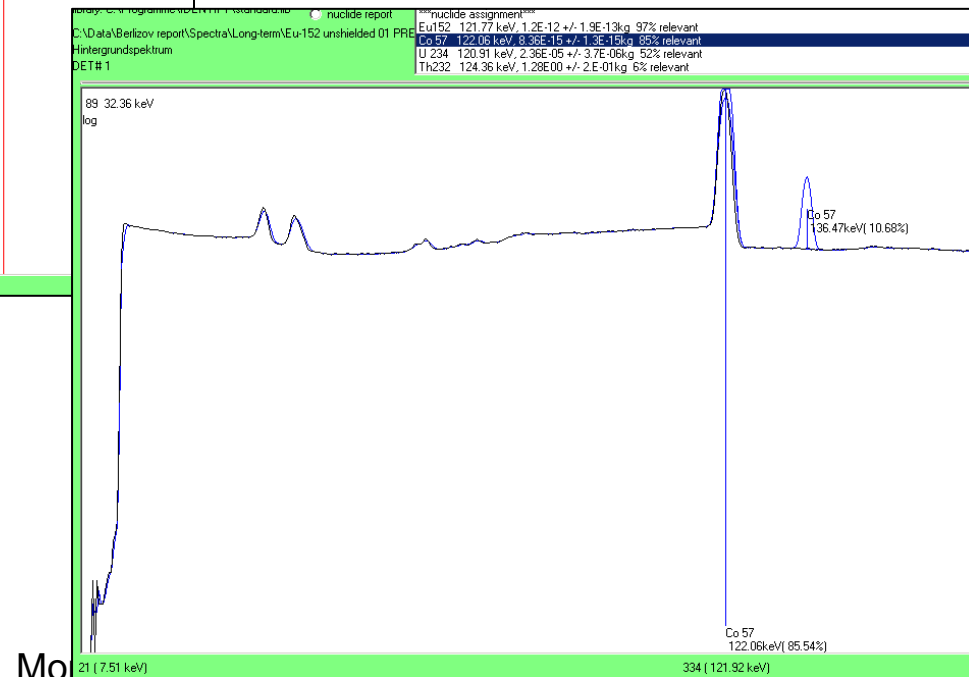
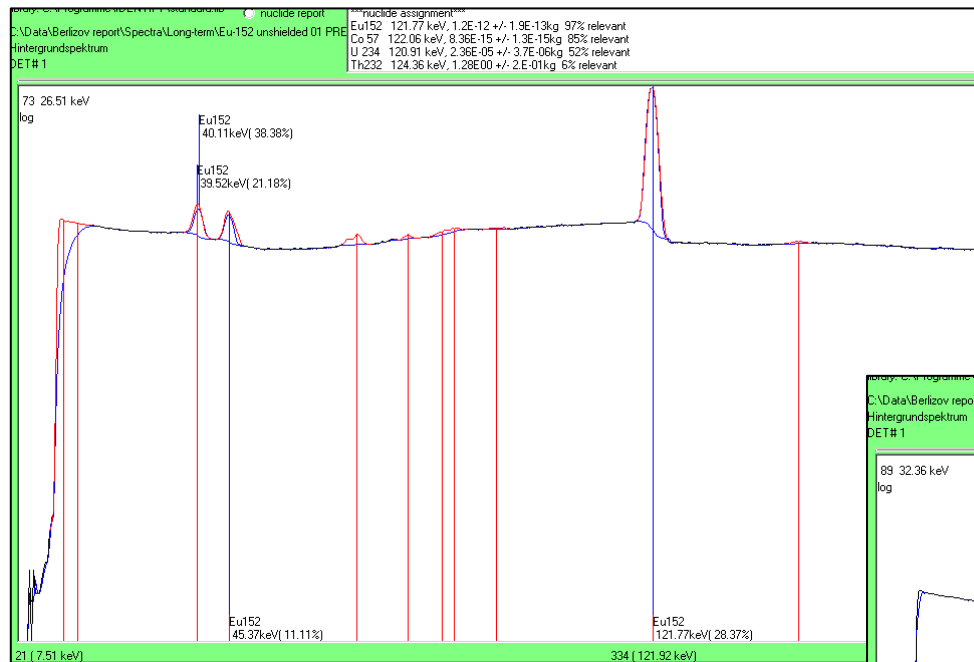


Save/Recall Details of a Measurement Setting

- Measurement geometry
 - Distances
 - Filters
 - Matrix
- Detector parameters
 - Type, dimensions
 - Resolution as function of energy
- Language
- And more...



Isotope ID with Identify



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Mo

Application Centre with WESPA

Open Nucleonica with your password
WESPA at the Application Centre

➤ Application Centre
Mass Activity Calculator
Decay Engine
Dosimetry & Shielding
Range & Stopping Power
webKORIGEN
Decay Engine for Large Nuclide Sets
Universal Nuclide Chart
Transport & Packaging
Nuclide mixtures
Nucleonica Scripting
Library creation for 3rd party software
Gamma Spectrum Generator
Gamma Spectrum Generator Pro
easy Monte Carlo
Cambio file Converter
WESPA
Gamma Library
webGraph

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Load one of the Sample Spectra

Upload spectrum | Spectrum | Measurement setup | Input summary and Run | Peak analysis | Identify Report | Spectral Data | About Identify

Load an input spectrum or select one sample spectrum for identification!

Selected input spectrum:

OR

Sample spectra:

- ☐ Co60_Nal3x3.spe
- ☐ Cs137_Na3x3.spe
- ☐ I131-Cs137_Nal3x3.spe
- ☒ _Ba133_HPGe.spe
- ☐ _Eu152_HPGe.spe

View the spectrum

Display Sample Spectrum



Verify or Modify Setup

Nuclide Library:

☐ medical.lib
 ☐ natural.lib
 ☒ standard.lib
 ☐ Upload a Library

Please select the right detector type:

Dimensions in

Source to Detector distance:

Crystal length:

Crystal diameter:

Relative efficiency compared to 3"3" NaI: %

Effective photopeak sensitive area at 662 keV: mm²

mm

 mm

 mm

 mm

 mm

 mm

Energy resolution (FWHM) in keV at keV:

Energy resolution (FWHM) in keV at keV:

Assumed Accuracy: %

Last Check before Running Identify

Upload spectrum | Spectrum | Measurement setup | **Input summary and Run** | Peak analysis | Identify Report | Spectral Data | About Identify

Selected spectrum

_Ba133_HPGe.spe

Run Identify

Selected nuclide library

standard.lib

Selected detector geometry

Detector HPGe rel eff 50%

Detector area 27.34 cm²

Detector thickness 7 cm

Rel. efficiency compared to 3"3" NaI 42.01 %

Effective photopeak sensitive area at 662 keV 649.54 mm²

Distance detector to radiation source 25.0 cm

Proposed accuracy 10

Peak form

FWHM 0.8 /

FWexp 0 keV at 122 keV photon energy

1.8 /

0 keV at 1332 keV photon energy

Radiation window

Aluminium 0.5 mm

Germanium 0.5 mm

Beryllium 0 mm

Iron 0 mm

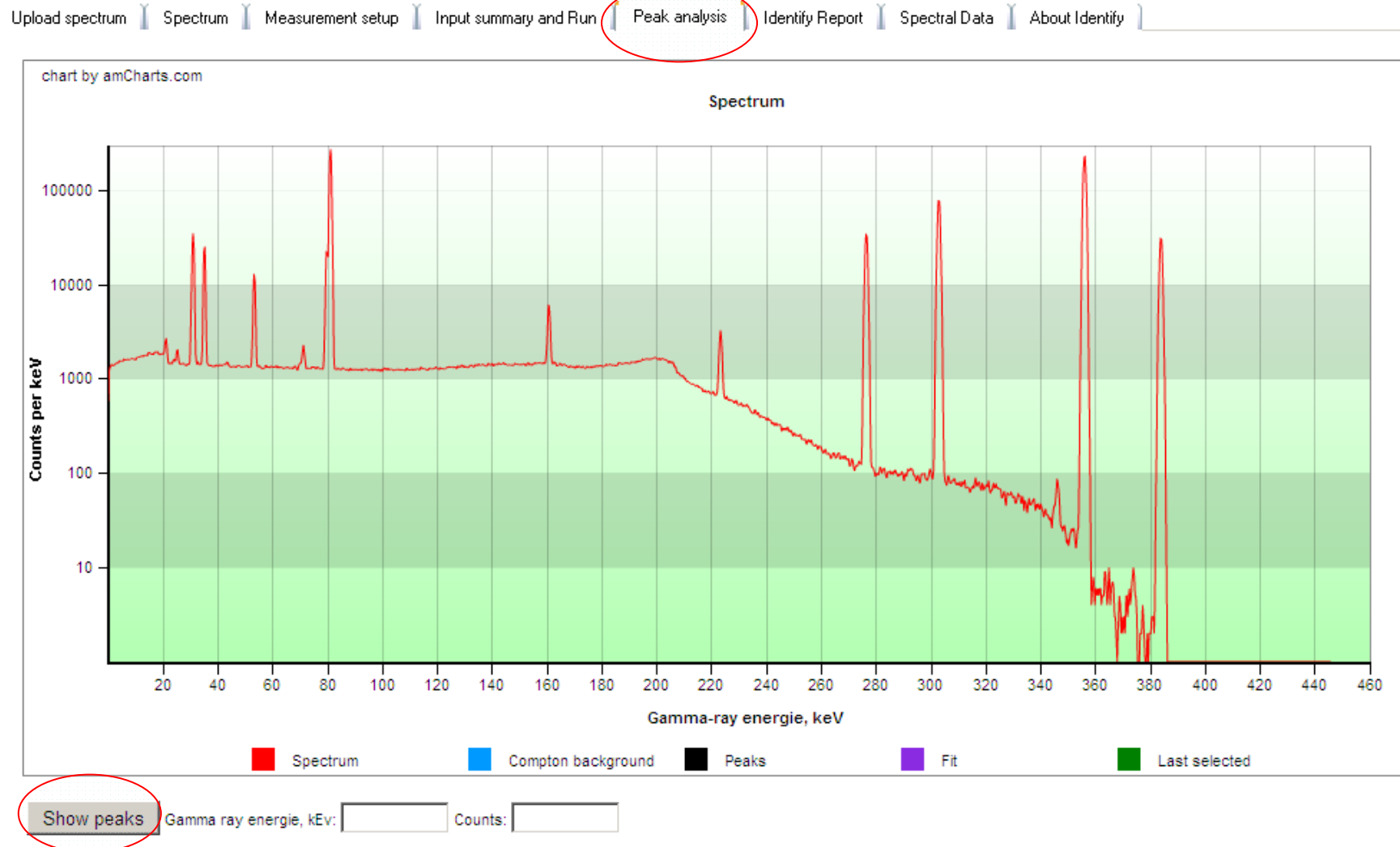
Absorber

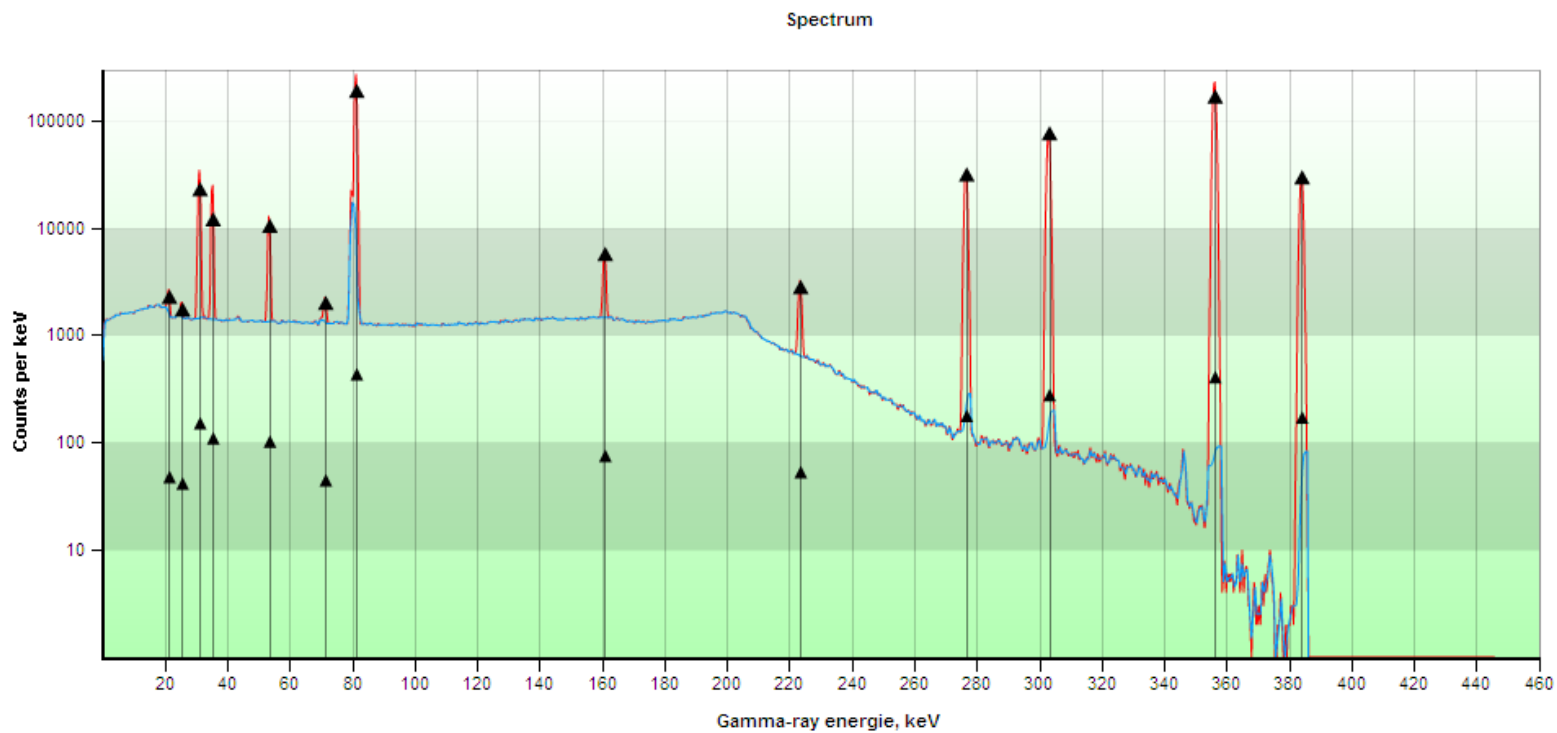
0.0 mm Tin

Matrix

0.0 mm Tin

“Show peaks” Marks the Peaks Found by Identify





■ Spectrum
 ■ Compton background
 ■ Peaks
 ■ Fit
 ■ Last selected

Gamma ray energy, keV:
 Counts:

Detected peaks. Click on the line in the table!!!

Energy	Chanel	FWHM	Area	Rating	Assigned Nuclide
21.32	71	2.604911	2986.789	1	

Table of Peaks Found

Detected peaks. Click on the line in the table!!!

Energy	Chanel	FWHM	Area	Rating	Assigned Nuclide
21.32	71	2.604911	2986.789	1	
25.45	85	2.288658	1483.72	1	
31.16	104	2.671621	96989.14	1	
35.29	118	2.365115	64820.25	1	
53.46	178	2.589359	32932.02	1	
71.42	238	2.898974	2921.501	1	
81.31	271	2.673545	769852.3	1	
160.91	536	3.145461	16105.94	1	
223.54	745	3.492194	9857.624	1	
276.69	922	3.64309	137005.9	1	
303.14	1010	3.749711	329040.6	1	
356.31	1188	3.922789	991704.8	1	
384.14	1280	3.993404	135364.2	1	

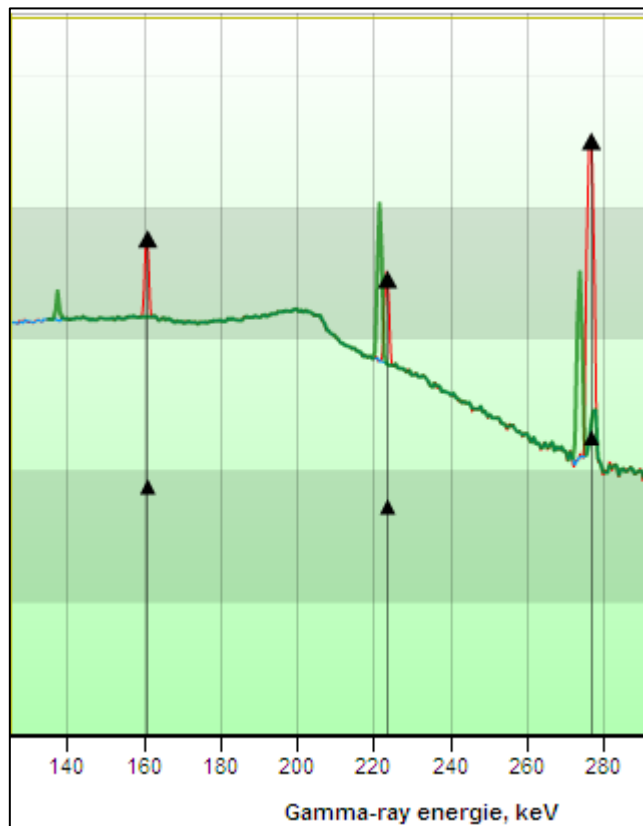
If a found gamma peak is selected and the corresponding row is clicked, other isotopes having gamma lines with similar energies pop up on the right:

Nuclide proposal. Click on the line in the table!!!

Nuclide	Energy from Library
Br 82	221.45
Ba133	223.23
Pu239	225.38
Te132	228.26

First Br-82 is clicked in the spectrum other lines of this isotope show up

Gamma Lines Belonging to Br82

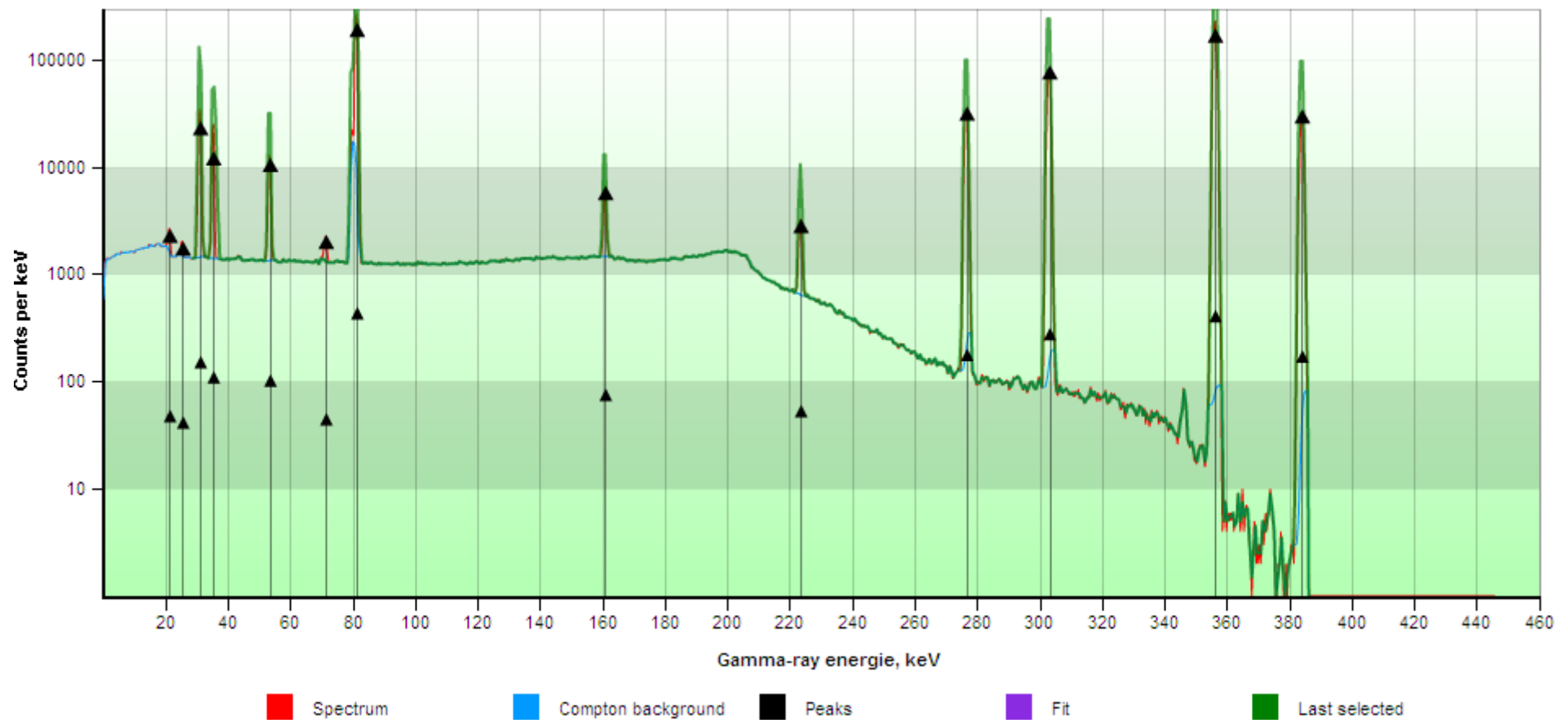


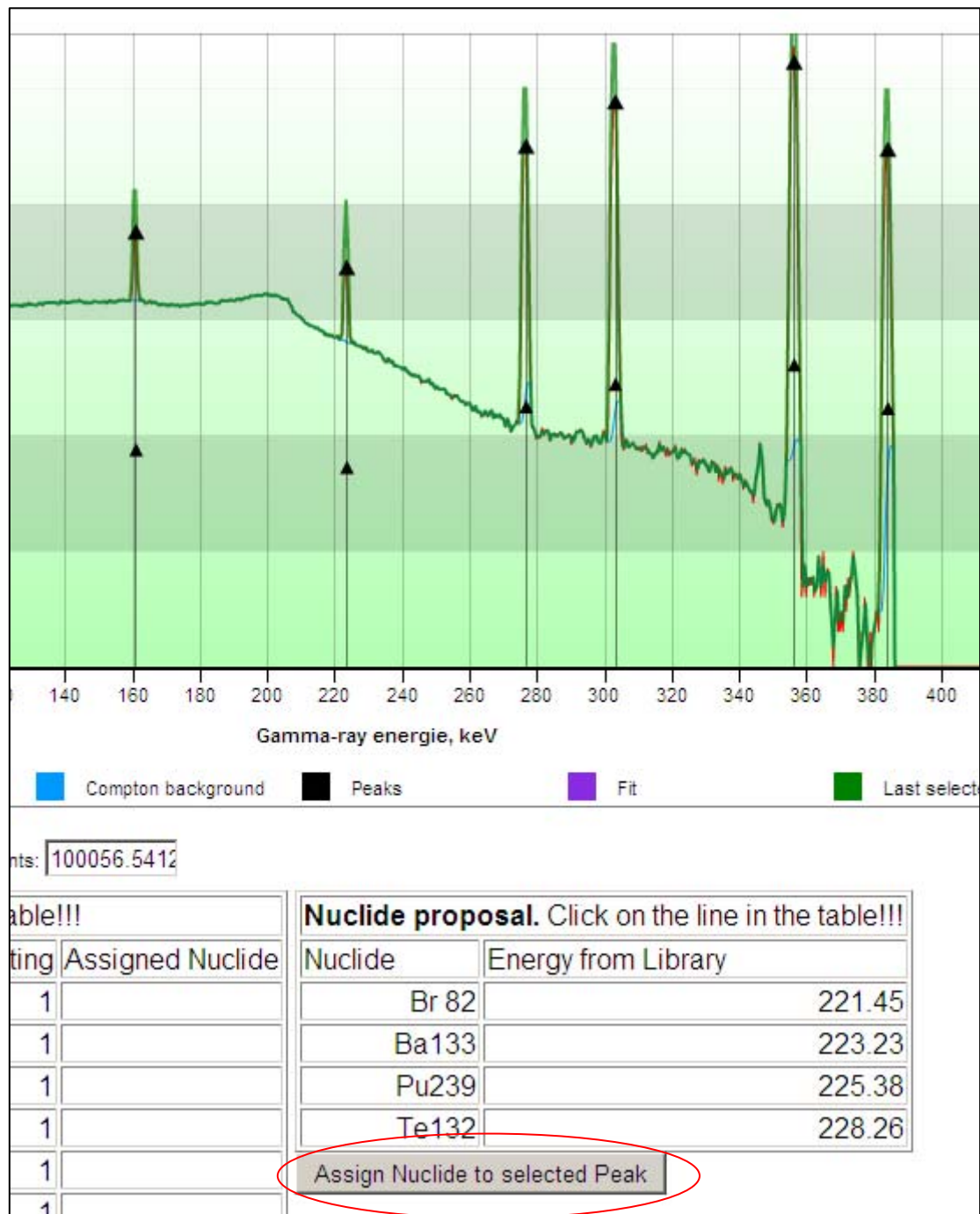
The gamma lines of Br82 are overlaid to the measured spectrum. But they do not coincide with measured lines, Br82 can be excluded

Next the Ba133 peak at 233 keV is clicked...

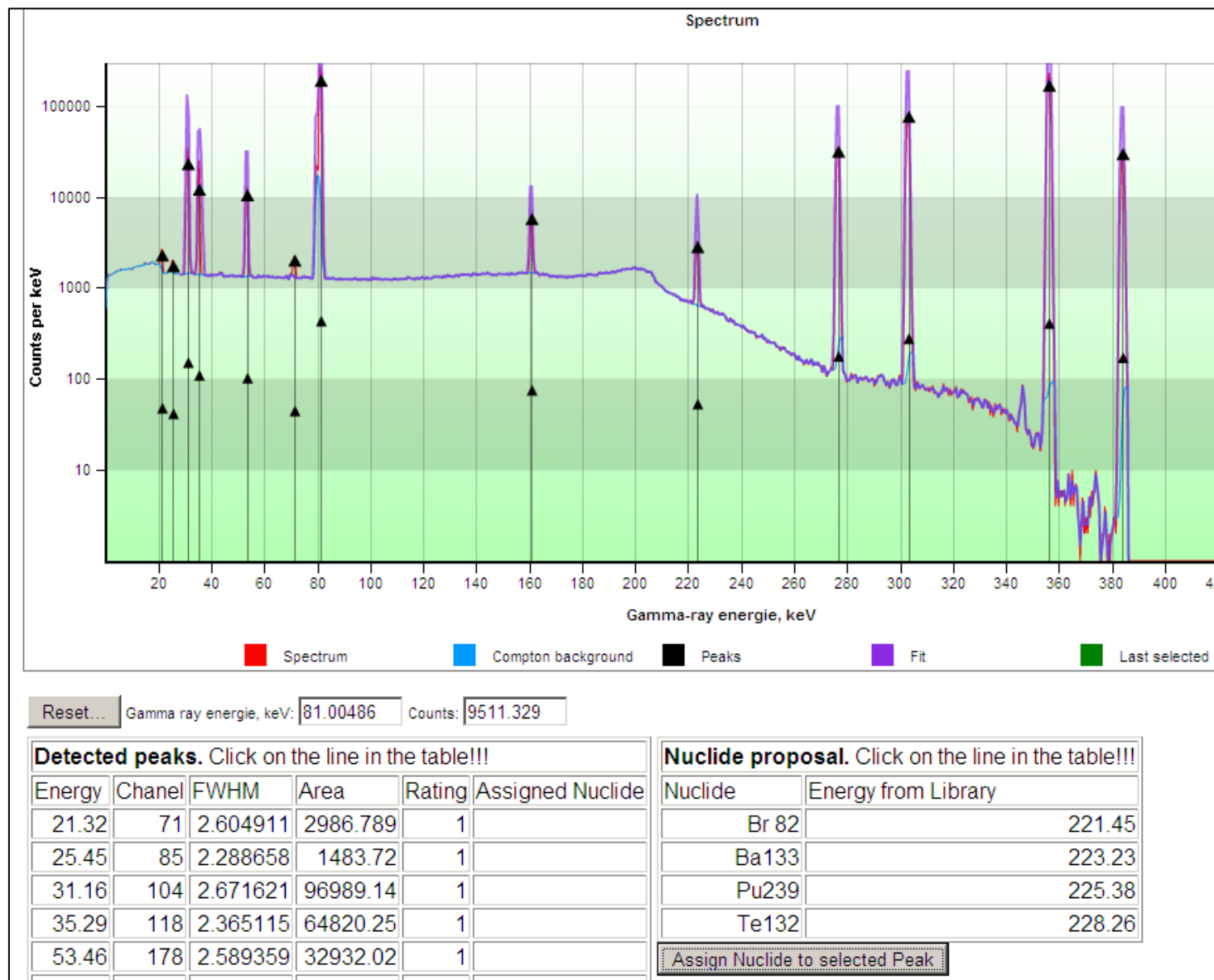
Ba133 Coincides

Spectrum





Ba133 can be assigned to this gamma spectrum - click the tab "Assign the Nuclide to selected Peak". Then the color of the Lines changes to purple (Fit) and the job is completed.



Acceptance of a Match

- The following peak parameters must coincide
 - Peak location (energy)
 - Peak area
 - Completeness (all significant peaks of an isotope present)

Identify and WESPA

- Intuitive
- Interactive
- Web based
- Operator decides after visualization
- Trained human experts enhance isotope ID algorithm

Identify and WESPA

- Identify is a stand alone ID program
- Matching of tabulated energies and peak areas with measured values
- Visual check
- WESPA – adaption of Identify to the Nucleonica.net platform
- Use where-ever Internet available

Usage of Radionuclide ID

- Nuclear security and Safeguards, e.g.:
 - Pocket and hand held devices (RIDs)
 - HPGe detector based gamma spectrometer and ID software
 - Monitoring of pedestrians, luggage and goods at airports
 - Sea and land borders
 - Security of major public events
- Waste characterization
- Environmental studies
- Radioecology
- Emergency response
- Nuclear facilities

Detection and Response at the Border

- Large size vehicle monitor alarms
- Stop and confirmation of the alarm
- Localization and secondary inspection, e.g.
 - Search with handheld device (RID)
 - Assess dose rate (safety)
 - Isotope ID to determine response
- Support team is called...
- ...to measure spectrum with HPGe



Equipment Test Workshop at the IAEA in 2008



Systems based on
NaI
HPGe (electrically cooled)
Handheld, and
Human portable devices

Spectral Pedestrian Radiation Monitor, 2nd Field Test at the Airport, Vienna (2009/10)



Spectral Personal Radiation Detectors, Performance Like RID, Require Longer Exposure



Atomtex, NaI



ICx US, CZT
Interceptor



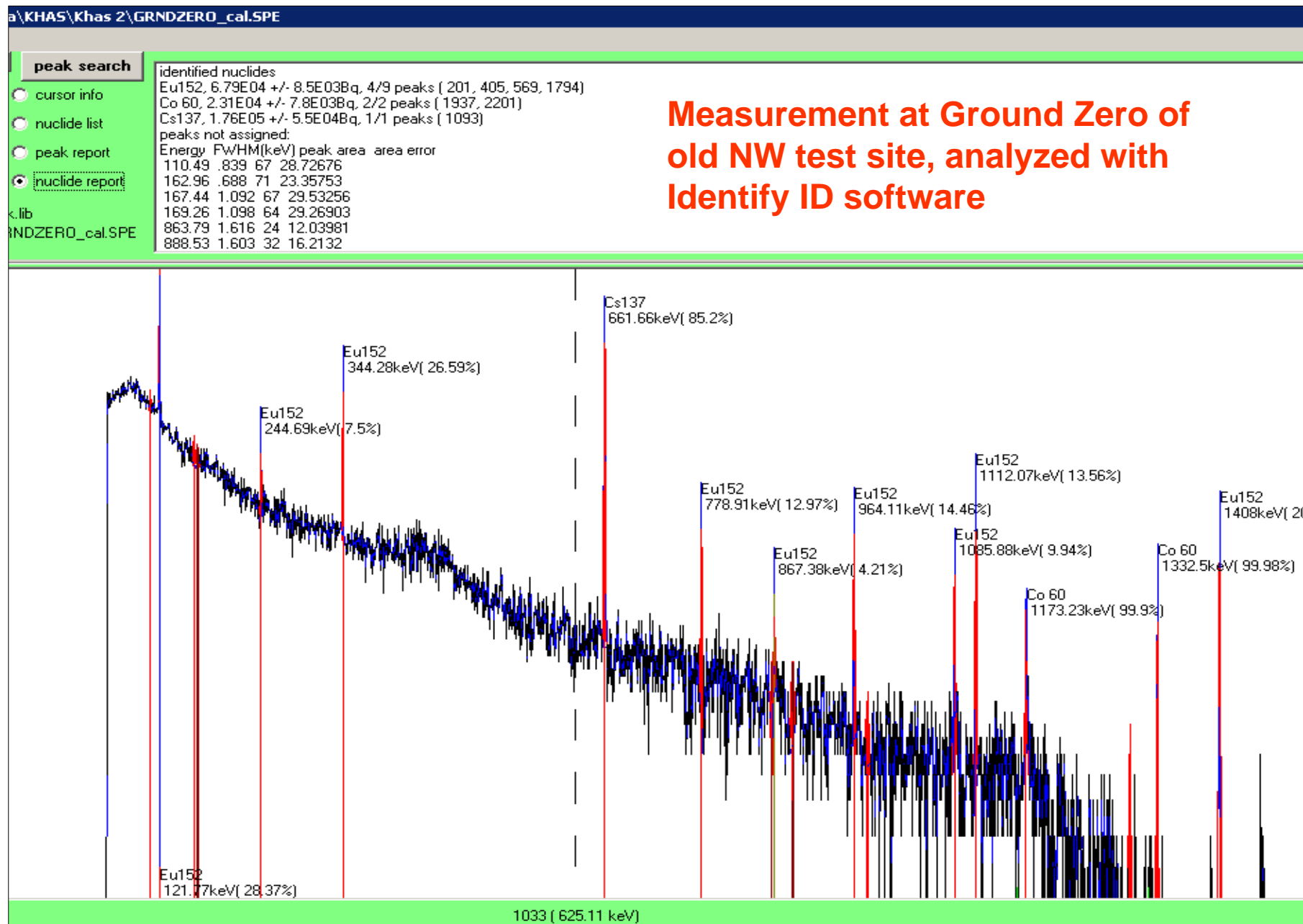
ICx US, CZT
Raider



Mirion, NaI



Georadis, NaI



10/19/2010 Gamma lines (energies and intensities) are matched with spectrum, 39
 Compton background is approximated by smooth line

Automated, Backpack-Based ID System with GPS Coupling

- Allows covert operation
 - GPS tagged spectrum collection
 - Isotope identification in real time
 - Data recording in PDA
 - Post processing with Google Earth
- Security of major public Events





Abbreviations

- FP Fingerprint
- MCA Multichannel Analyzer
- ID Isotope identification
- RID Radioisotope Identification Device
- WESPA **Web-based Spectrum Analyser**
- HPGe High Purity Germanium Detector
- NaI Sodium Iodide Detector
- CZT Cadmium Zink Telluride
- RT Real time
- PDA Personal Digital Assistant
- GPS Global Positioning System